[0200] 29627860

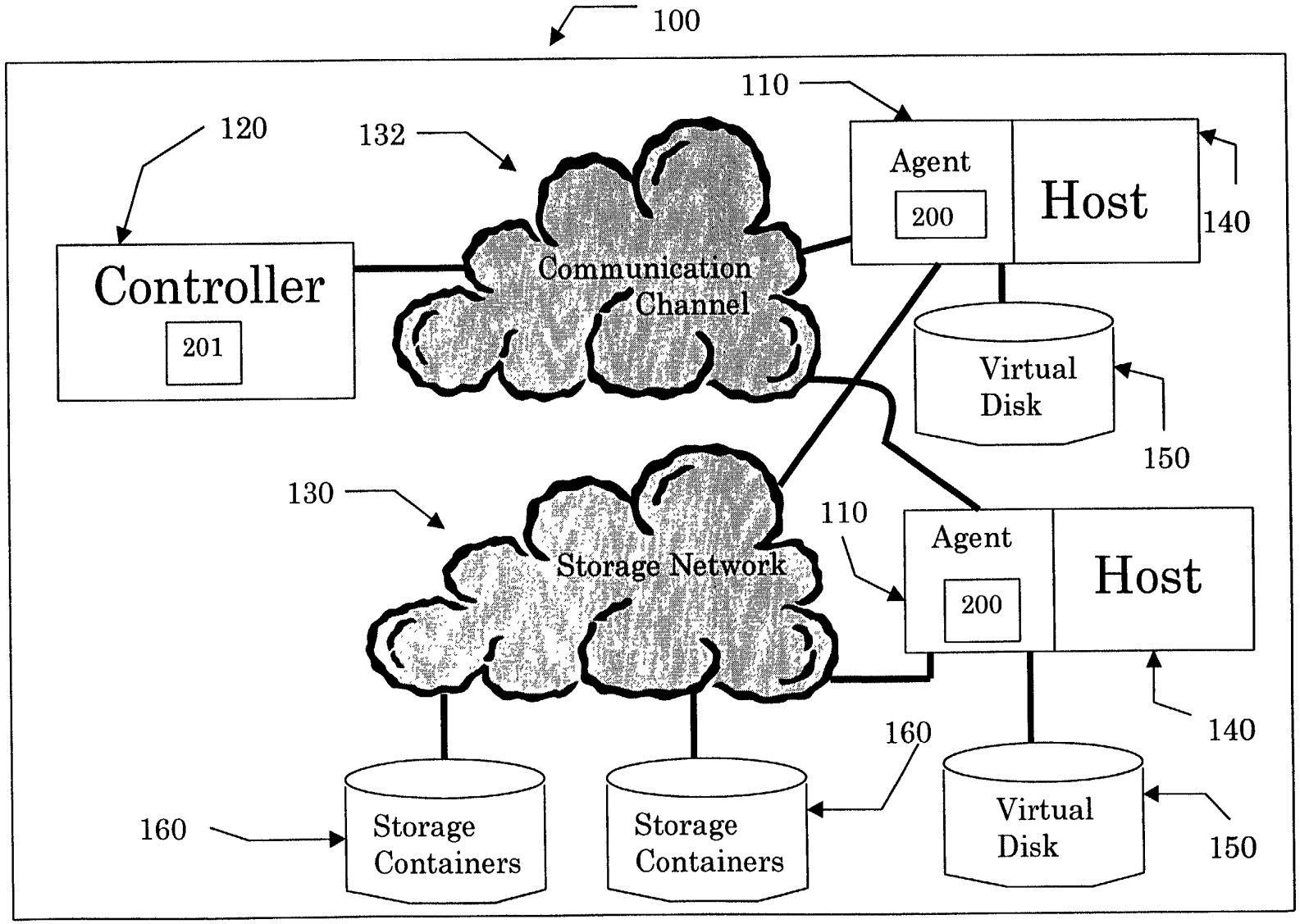

Figure 1A

TO2007 2962860

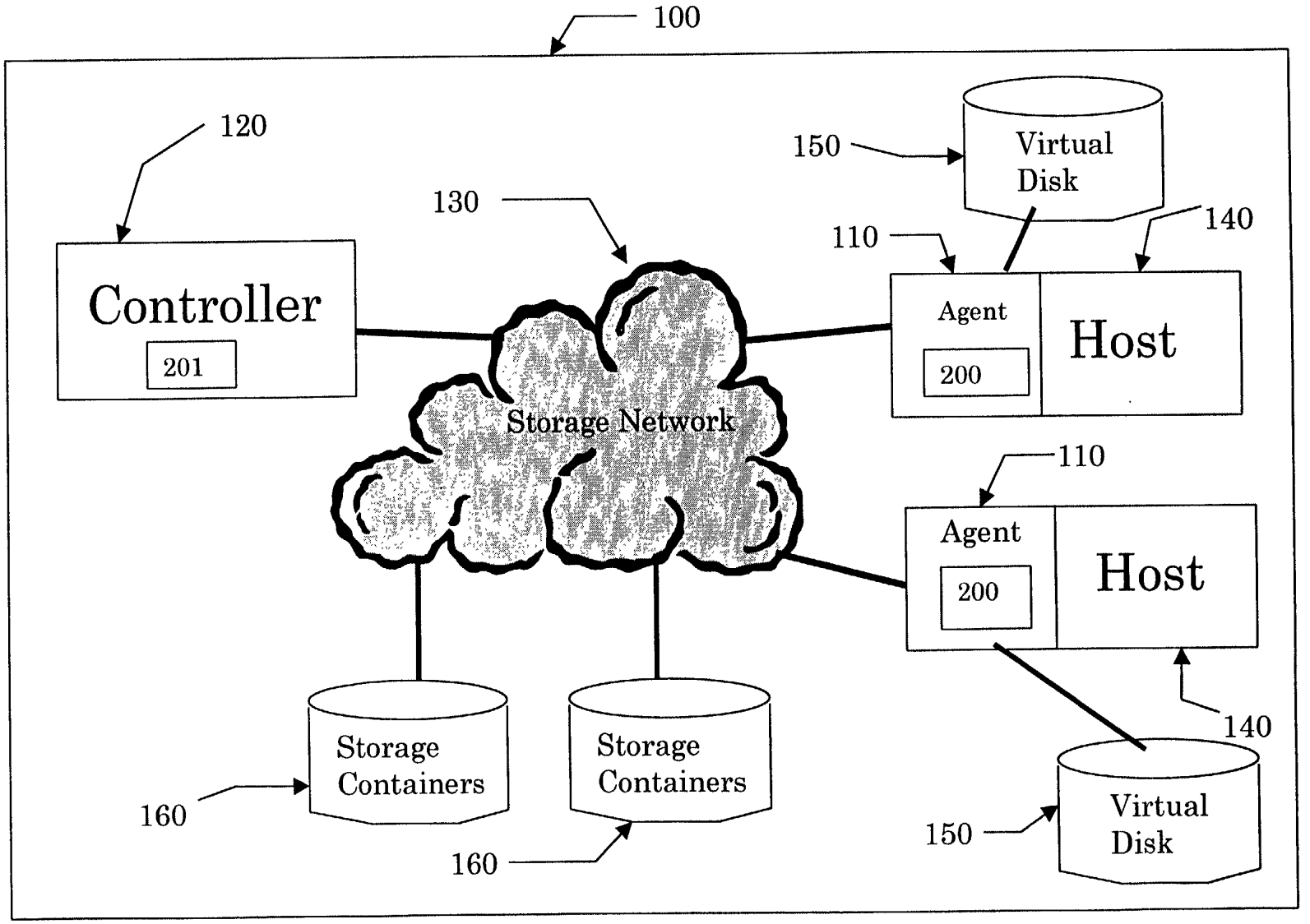

Figure 1B

T02001 "2962860

	Virtual Disk Block(2) 220	Storage Location 230		Alternate Storage Location 235		Invalid 240	Nw 250	Z 260	Error 270	Alternate Exists? 255	Bitmap 225
		LUN 232	Block(s) 234	LUN 236	Block(2) 238						
210→	1-10	1	1-10	2	11-20	no	no	no	no	yes	3,8,9
210→	11-20	2	1-10	2	21-30	no	yes	no	no	no	
210→	21-20	1	11-20	1	21-30	no	no	no	no	no	

↑

201

Figure 2A

	Virtual Disk Block(2) 220	Storage Location 230		Invalid 240	Nw 250	Z 260	Error 270	Alternate Exists? 255	Alternate Table 215
		LUN 232	Block(s) 234						
210→	1-10	1	1-10	no	no	no	no	yes	1
210→	11-20	2	1-10	no	yes	no	no	no	
210→	21-20	1	11-20	no	no	no	no	no	

↑
203

Alternate Table #1 (215)			
Virtual Disk Block(2) 220	Alternate Storage Location 235		Bitmap 225
	LUN 236	Block(2) 238	
1-10	2	11-20	3,8,9
11-20	2	21-30	
21-20	1	21-30	

↑
206

201

Figure 2B

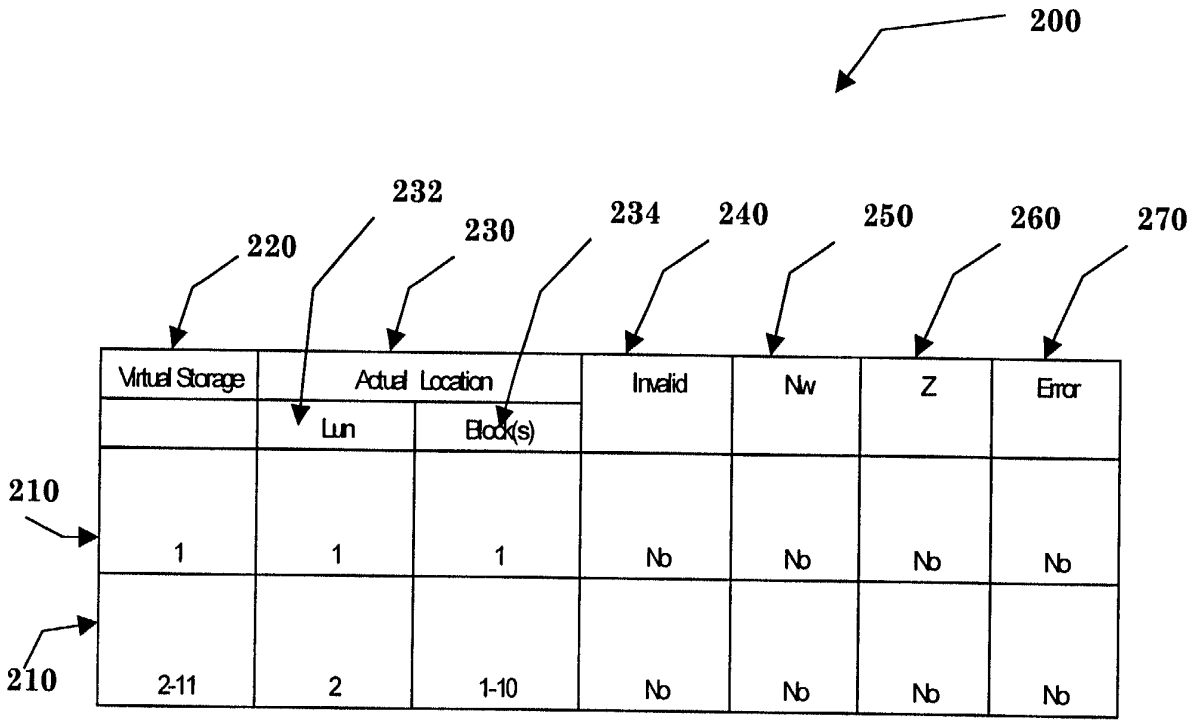
200
232
220
230
234
240
250
260
270
Virtual Storage
Actual Location
Lun
Block(s)
Invalid
Nw
Z
Error
210
1
1
1
No
No
No
No
210
2-11
2
1-10
No
No
No
No

Figure 2C

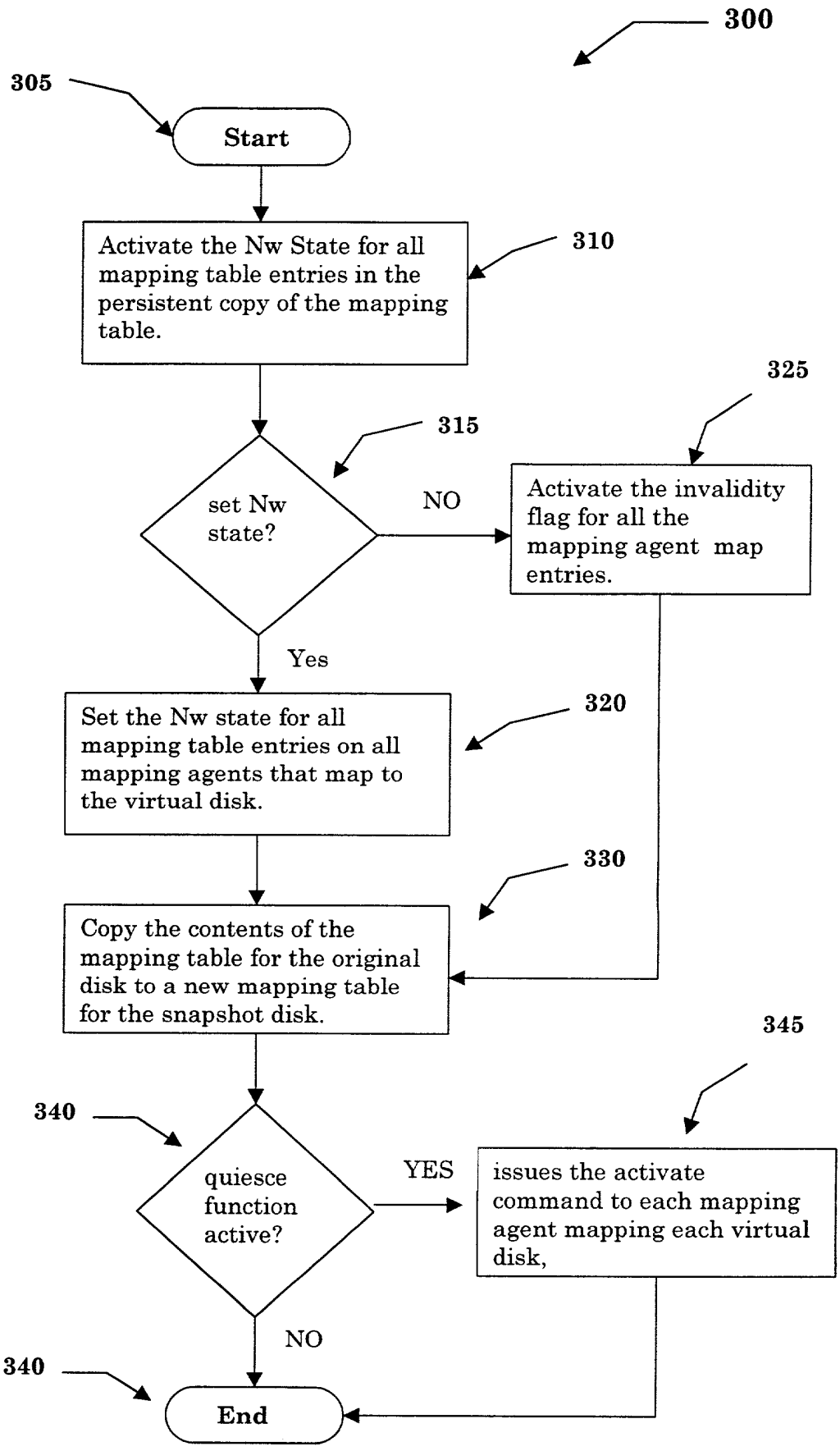
300
305
Start
Activate the Nw State for all mapping table entries in the persistent copy of the mapping table.
310
325
315
set Nw state?
NO
Activate the invalidity flag for all the mapping agent map entries.
Yes
Set the Nw state for all mapping table entries on all mapping agents that map to the virtual disk.
320
330
Copy the contents of the mapping table for the original disk to a new mapping table for the snapshot disk.
345
340
quiesce function active?
YES
issues the activate command to each mapping agent mapping each virtual disk,
NO
340
End

Figure 3

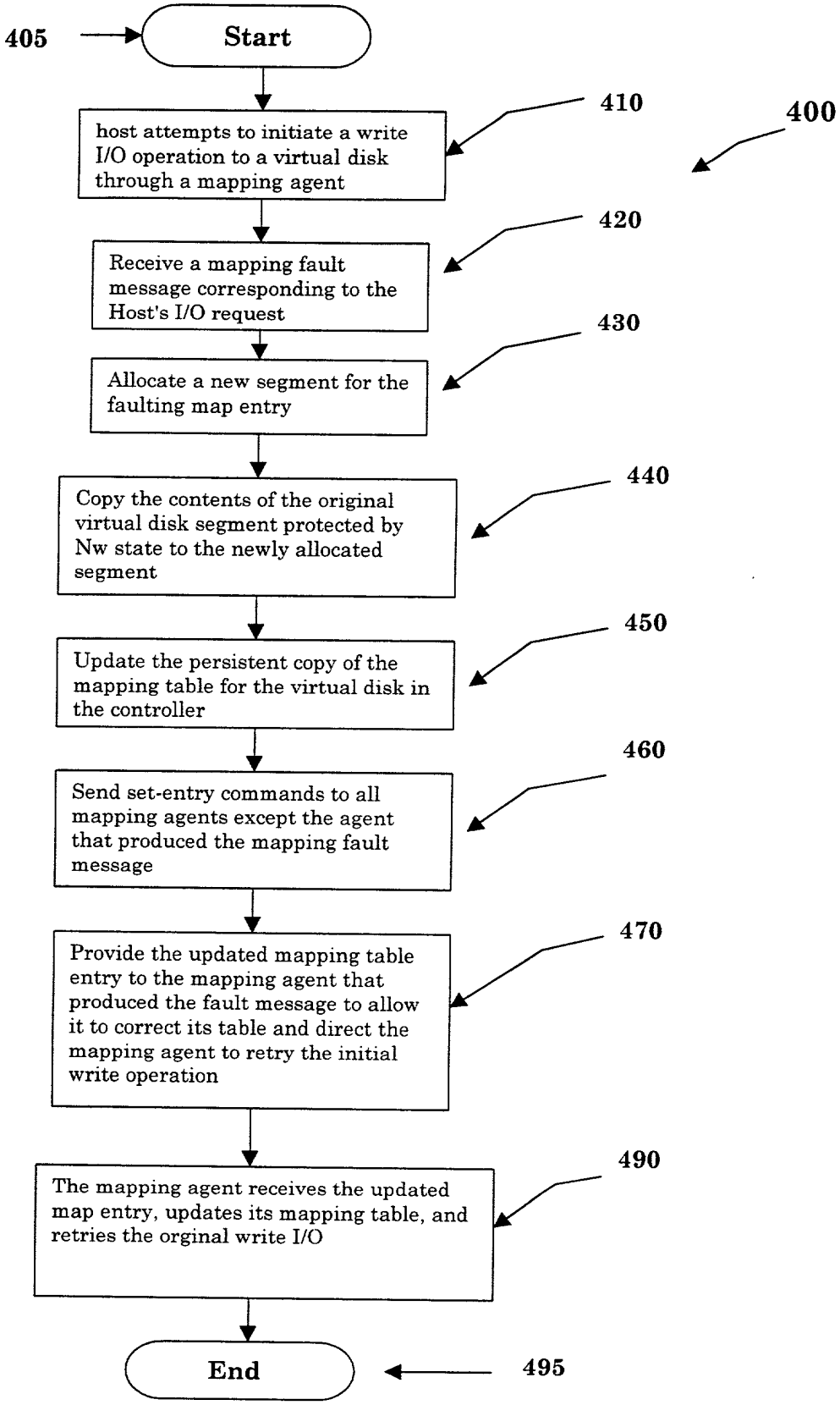
405
Start
410
400
host attempts to initiate a write I/O operation to a virtual disk through a mapping agent
420
Receive a mapping fault message corresponding to the Host's I/O request
430
Allocate a new segment for the faulting map entry
440
Copy the contents of the original virtual disk segment protected by Nw state to the newly allocated segment
450
Update the persistent copy of the mapping table for the virtual disk in the controller
460
Send set-entry commands to all mapping agents except the agent that produced the mapping fault message
470
Provide the updated mapping table entry to the mapping agent that produced the fault message to allow it to correct its table and direct the mapping agent to retry the initial write operation
490
The mapping agent receives the updated map entry, updates its mapping table, and retries the orginal write I/O
End
495

Figure 4

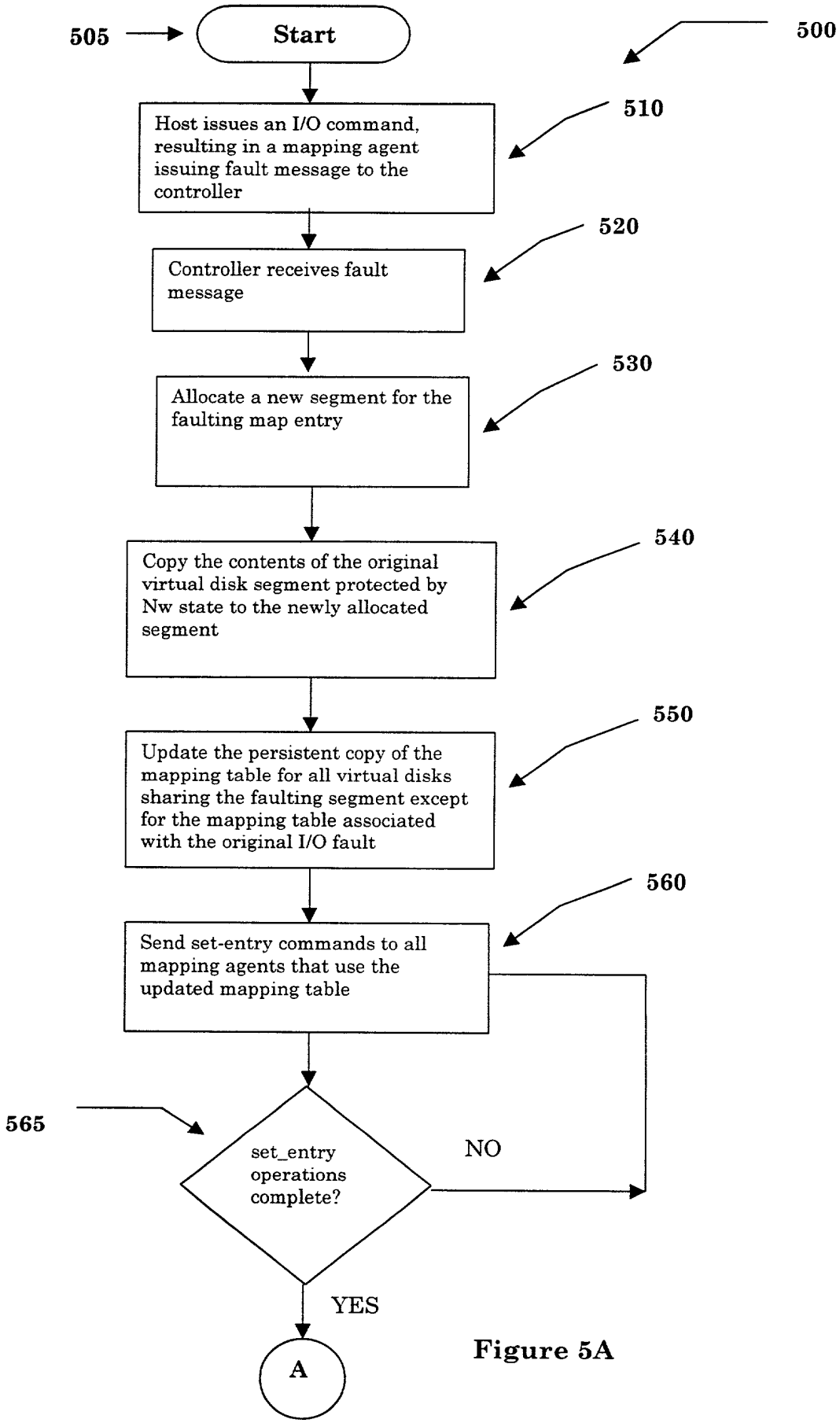
505
Start
500
510
Host issues an I/O command, resulting in a mapping agent issuing fault message to the controller
520
Controller receives fault message
530
Allocate a new segment for the faulting map entry
540
Copy the contents of the original virtual disk segment protected by Nw state to the newly allocated segment
550
Update the persistent copy of the mapping table for all virtual disks sharing the faulting segment except for the mapping table associated with the original I/O fault
560
Send set-entry commands to all mapping agents that use the updated mapping table
565
set_entry operations complete?
NO
YES
A

Figure 5A

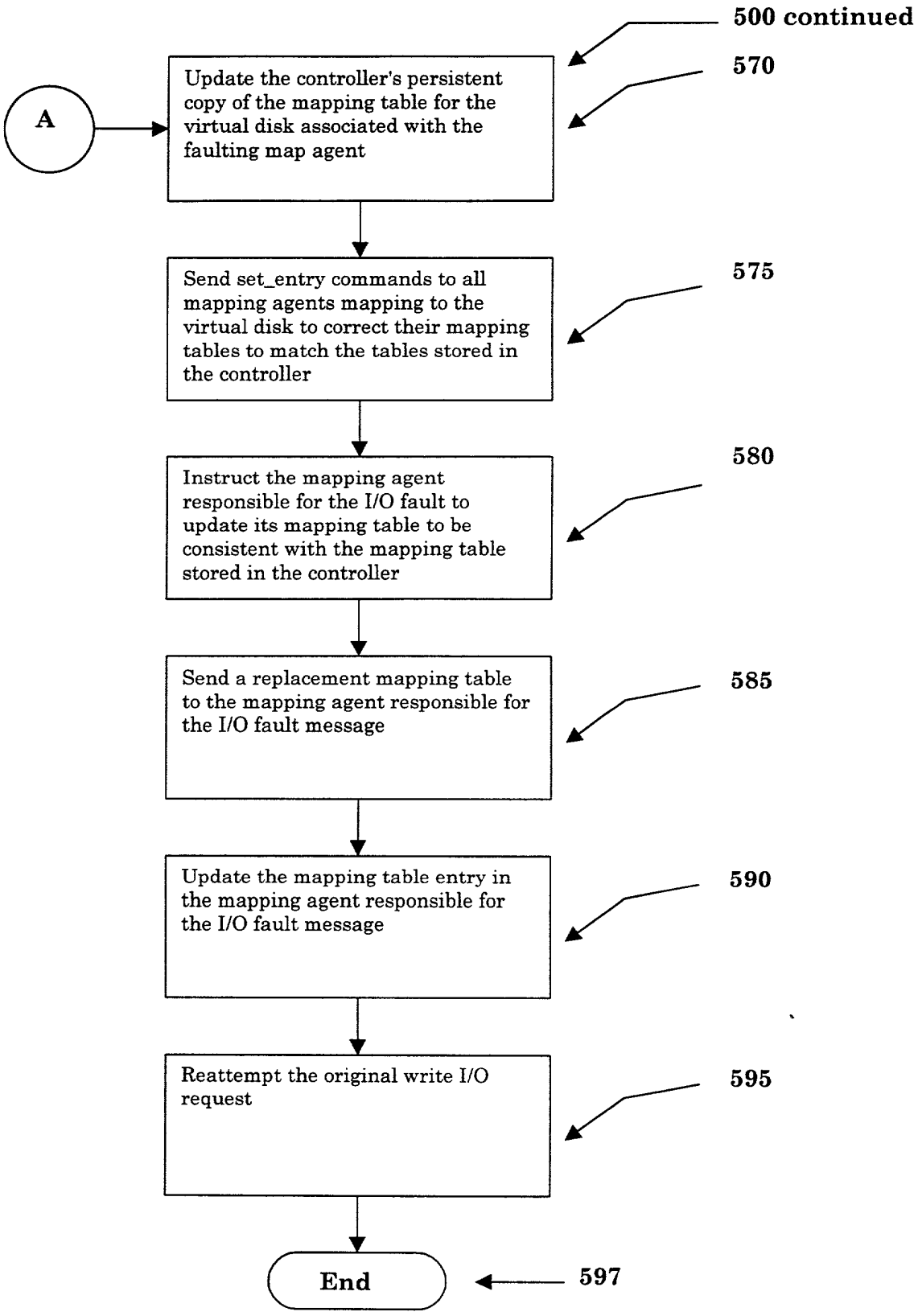
500 continued
A
Update the controller's persistent copy of the mapping table for the virtual disk associated with the faulting map agent
570
Send set_entry commands to all mapping agents mapping to the virtual disk to correct their mapping tables to match the tables stored in the controller
575
Instruct the mapping agent responsible for the I/O fault to update its mapping table to be consistent with the mapping table stored in the controller
580
Send a replacement mapping table to the mapping agent responsible for the I/O fault message
585
Update the mapping table entry in the mapping agent responsible for the I/O fault message
590
Reattempt the original write I/O request
595
End
597

Figure 5B

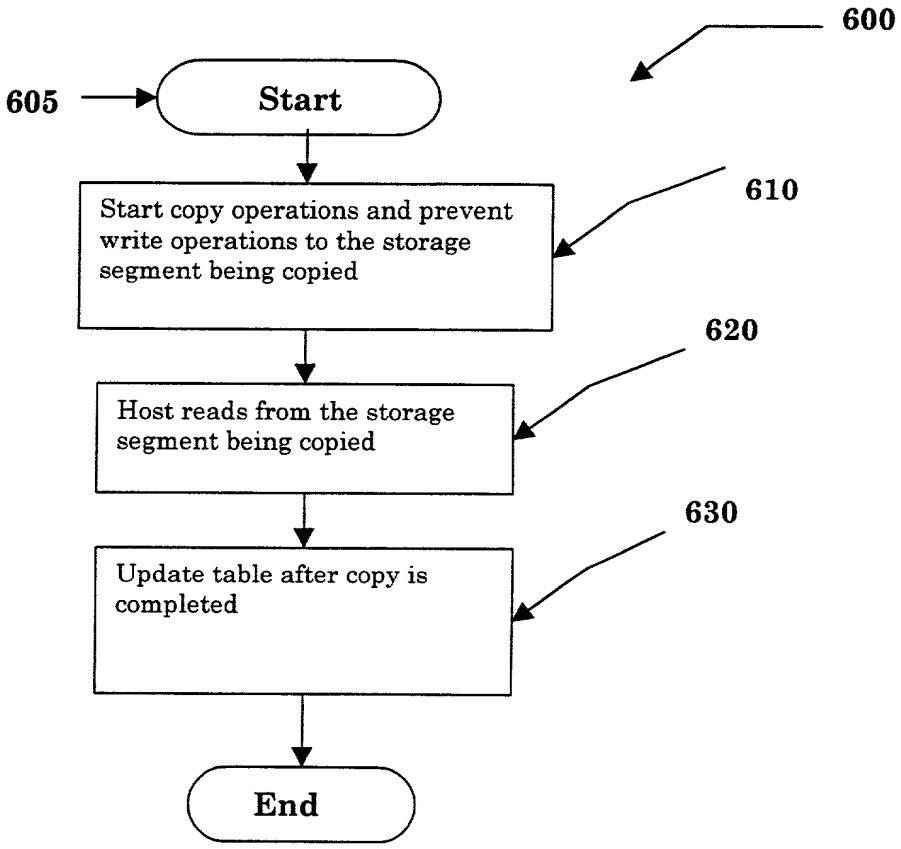
600
605
Start
610
Start copy operations and prevent write operations to the storage segment being copied
620
Host reads from the storage segment being copied
630
Update table after copy is completed
End

Figure 6A

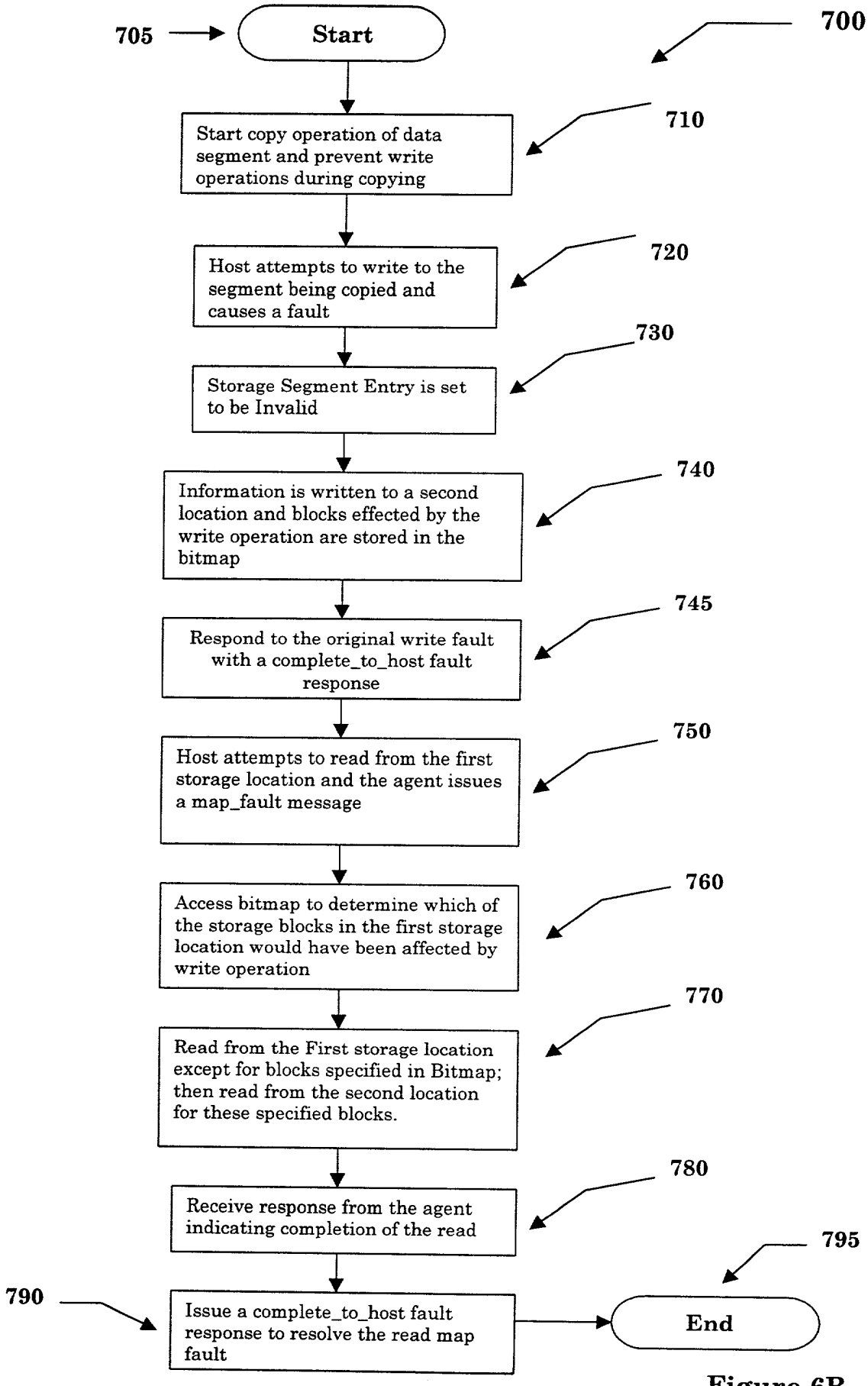
705
Start
700
Start copy operation of data segment and prevent write operations during copying
710
Host attempts to write to the segment being copied and causes a fault
720
Storage Segment Entry is set to be Invalid
730
Information is written to a second location and blocks effected by the write operation are stored in the bitmap
740
Respond to the original write fault with a complete_to_host fault response
745
Host attempts to read from the first storage location and the agent issues a map_fault message
750
Access bitmap to determine which of the storage blocks in the first storage location would have been affected by write operation
760
Read from the First storage location except for blocks specified in Bitmap; then read from the second location for these specified blocks.
770
Receive response from the agent indicating completion of the read
780
Issue a complete_to_host fault response to resolve the read map fault
790
End
795

Figure 6B